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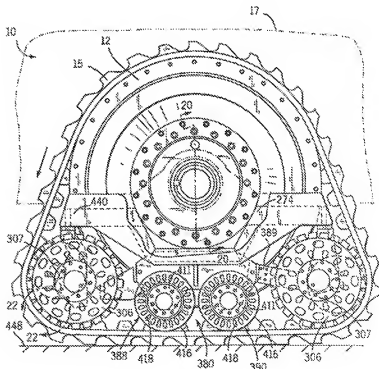
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(54) Title: GUIDE WHEEL FOR FLEXIBLE TRACK OF A TRACK SYSTEM

(57) Abstract

A guide wheel (320) for a track apparatus (10) is provided. The guide wheel (320) includes a central hub (322) rotatably mounted to a frame (274) of a track apparatus (10). A first guide wall (328) extends radially from the central hub (322) and terminates at an outer edge (336). A second guide wall (330) also extends radially from the central hub (322) and terminates at an outer edge (338). The first and second guide walls (328 and 330) define a circumferentially extending channel (342) in the guide wheel (320). The channel (342) in the guide wheel (320) sequentially receives a plurality of lugs (341) extending from the inner surface (343) of a flexible track (15) of the track apparatus (10) so as to prevent lateral movement of the track (15).



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5 Title: GUIDE WHEEL FOR FLEXIBLE TRACK OF A TRACK SYSTEM

Background and Summary of the Invention

 This invention relates to a track system for
vehicles, and in particular, to a guide wheel for
10 guiding a continuous flexible track of a track system on
 its path.

 Agricultural implements such as tractors, combines
and the like are commonly used in agricultural fields for
a variety of jobs. Typically, these agricultural
15 implements incorporate tires on which the implement is
 supported. Since these types of large agricultural
 implements are quite heavy, the weight of agricultural
 implements are distributed to a relatively small area on
 the tires of the implements. As a result, the tires on
20 the agricultural implements tend to compact the soil in
 the fields. Compacted soil discourages the growth of
 crops planted in the fields which need loose soil to
 flourish.

 In addition, since agricultural fields are often wet
25 due to rain or watering, agricultural implements which
 enter the fields become bogged down in the mud due to the
 fact that there is such a small area of the tire in
 contact with the soil. As such, it is highly desirable
 to develop a track system for vehicles which disbursts
30 the weight of the agricultural implement over a larger
 area so as to reduce the compaction of the soil in the
 agricultural fields and to provide a track with a larger
 surface area which contacts the soil so as to prevent the
 agricultural implement from becoming bogged down in mud
35 in the fields.

 A prior track system for vehicles is disclosed in
Kelderman, U.S. Patent No. 5,452,949, assigned to the

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Assignee of the present invention and incorporated herein by reference. The Kelderman '949 patent discloses a track suspension system for a vehicle having a frame and a continuous track. The drive wheel is attached to the frame for engaging and driving the continuous flexible track. The drive wheel has a plurality of drive projections disposed thereon which engage depressions in the rubber track. As the drive wheel rotates, it engages and drives the continuous flexible track. As the drive wheel drives the continuous flexible track about the leading and trailing idler assemblies, the flexible track tends to slide laterally with respect to the idler assemblies. This, in turn, reduces the engagement of the flexible track with the idler wheels which, in turn, may reduce the efficiency of the track system.

Heretofore, the inside surfaces of the idler wheels served to guide the flexible track by contacting the lugs projecting from the inner surface thereof when the track slides to far out of alignment. However, repeated contact of the lugs on the inside surface of the track with the idler wheels may cause damage to the flexible track and/or the idler wheels. Consequently, it would be highly desirable to provide a structure to guide the flexible track on its path around the idler assemblies.

Therefore, it is a primary object and feature of the present invention to provide a guide wheel for engaging and guiding a continuous flexible track of a track system on its path.

It is a further object and feature of the present invention to provide a guide wheel for engaging and guiding a continuous flexible track of a track system which does not damage the track during extended use.

It is a still further object and feature of the present invention to provide a guide wheel for engaging and driving a continuous flexible track of a track system which easily incorporates into the track system.

In accordance with the present invention, a guide wheel is provided for a track apparatus for having a frame; a continuous flexible track having an upper length and ground engaging lower length and an inner surface having a lug projecting therefrom; a drive wheel structure rotatably mounted with respect to the frame and having an upper circumferential portion engaging the inner surface of the flexible track along the upper length and a lower circumferential portion spaced above the lower track length; and an idler assembly attached to the frame and having an idler wheel engaging the flexible track. The guide wheel includes a central hub rotatably mounted to the frame. A first guide wall extends radially from the central hub and terminates at an outer edge. The second wall also extends radially from the central hub and terminates at an outer edge. The first and second guide walls guide the flexible track onto the idler roller.

The first and second guide walls define a circumferentially extending lug receiving channel in the guide wheel wherein receipt of the lug with the lug-receiving channel prevents lateral movement of the flexible track. The outer edge of the first guide wall has a predetermined radius such that the outer edge of the first wall forms a mating relationship with a portion of the continuous flexible track adjacent the lug. Similarly, the outer edge of the second guide wall has a predetermined radius such that the outer edge of the second guide wall forms a mating relationship with the second portion of the continuous flexible track adjacent the lug.

In accordance with a further aspect of the present invention, a track apparatus having a frame is provided. The track apparatus is mountable on a rotatable axle of a vehicle and includes a continuous flexible track having an upper length and a ground engaging lower length. The flexible track includes an inner surface having a

plurality of lugs projecting therefrom. A drive wheel is mountable to the rotatable axle of the vehicle for rotational movement therewith. The drive wheel sequentially engages the plurality of lugs projecting from the inner surface of the flexible track along the upper length to drive the flexible track in response to rotation of the axle of the vehicle. A leading idler assembly is mounted to the frame. The leading idler assembly includes a rotatable leading idler wheel engaging the inner surface of the flexible track. A leading guide wheel is rotatably mounted to the frame. The leading guide wheel includes a circumferentially extending lug receiving channel for sequentially receiving the plurality of lugs therein and guiding the flexible track onto the leading idler wheel.

The track apparatus further includes a trailing idler assembly mounted to the frame. The trailing idler assembly includes a rotatable, trailing idler wheel for engaging the inner surface of the flexible track. A trailing guide wheel is rotatably mounted to the frame. The trailing guide wheel engages the inner surface of flexible track and guides a portion of the flexible track engaging the trailing idler wheel. The leading idler wheel includes a central hub having first and second guide walls projecting radially therefrom. The guide walls define a lug receiving channel in the leading guide wheel. Each of the guide walls of the leading guide wheel terminate at a radially outer edge. The radially outer edge of each guide wheel has a predetermined radius.

Each of the plurality of lugs projecting from the inner surface of the flexible track includes first and second side walls. Each side wall intersects the inner surface of the flexible track at a junction. The junction of each side wall of each lug with the inner surface of the flexible track has a predetermined radius. The predetermined radius of the outer edge of guide wall

of the leading guide wheel is generally equal to the predetermined radius of each junction.

In accordance with a still further aspect of the present invention, a track apparatus having a frame is provided. The track apparatus is mountable on a rotatable axle of a vehicle and includes a continuous flexible track having an upper length and ground-engaging lower length. The flexible track includes an inner surface having a plurality of lugs projecting therefrom. A drive wheel is mountable to the rotatable axle of the vehicle for rotational movement therewith. The drive wheel sequentially engages the plurality of lugs projecting from the inner surface of the flexible track along the upper length so as to drive the flexible track in response to rotation of the axle of the vehicle. A leading idler assembly is mounted to the frame and includes first and second leading idler wheels. The leading idler wheels are rotatable about and spaced along a common idler axis parallel to the axle of the vehicle. A leading guide wheel is positioned between the first and second leading idler wheels and is rotatably mounted to the frame. The leading guide wheel is rotatable about a guide wheel axis parallel to and radially spaced from the idler axis.

The leading idler assembly includes first and second stub axles rotatably mounted to the frame. Each leading idler wheel is mounted on a corresponding stub axle.

A leading guide wheel includes a central hub having first and second guide walls extending therefrom and which terminate at a radially outer edge. The first and the second guide walls define a circumferentially extending lug receiving void in the leading guide wheel wherein receipt of one of the plurality of lugs in the lug receiving void prevents lateral movement of a flexible track.

The track apparatus further includes a trailing idler assembly mounted to the frame. The trailing idler

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assembly includes first and second trailing idler wheels which are rotatable about and spaced along a common trailing idler axis parallel to the axle of the vehicle. A trailing guide wheel is positioned between the first
5 and second trailing idler wheels and is rotatably mounted to the frame. The trailing guide wheel is rotatable about a trailing guide wheel axis parallel to and radially spaced from the trailing idler axis. The trailing guide wheel includes a central hub having first
10 and second guide walls extending radially therefrom and which terminate at a radially outer edge. The first and second guide walls define a circumferentially extending lug receiving void in the trailing guide wheel wherein receipt of one of the plurality of lugs in a lug
15 receiving void presents lateral movement of the flexible track.

The track apparatus may also include a mid-roller assembly mounted to the frame. The mid-roller assembly engages the inner surface of the lower length of the
20 flexible track.

Brief Description of the Drawings

The drawings furnished herewith illustrate a preferred construction of the present invention in which
25 the above advantages and features are clearly disclosed as well as others which will be readily understood from the following description of the illustrated embodiment.

FIGURE 1 is a side elevational view of a track system for a vehicle incorporating a drive wheel in
30 accordance with the present invention.

FIGURE 2 is a side elevational view, partially in section, showing the track system of FIGURE 1.

FIGURE 3 is a cross-sectional view of the track system taken along line 3-3 of FIGURE 2.

35 FIGURE 4 is a cross-sectional view of the track system taken along line 4-4 of FIGURE 2.

FIGURE 5 is a cross-sectional of a track system taken along line 5-5 of FIGURE 2.

FIGURE 6 is a exploded, side-elevational view, partially in section, showing the drive wheel of the present invention.

FIGURE 7 is a enlarged, cross-sectional view of the track system taken along line 7-7 of FIGURE 2.

FIGURE 8 is a cross-sectional view taken along line 8-8 of FIGURE 3 showing a first embodiment of a roller for the drive wheel in accordance with the present invention.

FIGURE 9 is a cross-sectional view, similar to FIGURE 8, showing a second embodiment of a roller for the drive wheel of the present invention.

FIGURE 10 is a cross-sectional view, similar to FIGURE 8, showing a third embodiment of a roller for the drive wheel of the present invention.

FIGURE 11 is a cross-sectional view of the track system taken along line 11-11 of FIGURE 2.

FIGURE 12 is a cross-sectional view taken along line 12-12 of FIGURE 11.

FIGURE 13 is a cross-sectional view taken along line 13-13 of FIGURE 3.

FIGURE 14 is a cross-sectional view of the track system taken along line 14-14 of FIGURE 2.

FIGURE 15 is a cross-sectional view of the track system taken along line 15-15 of FIGURE 2.

FIGURE 16 is a cross-sectional view taken along line 16-16 of FIGURE 15.

FIGURE 17 is an enlarged, cross-sectional view taken along line 17-17 of FIGURE 15.

FIGURE 18 is an isometric view of a drive spindle for the track system shown in FIGURE 1.

FIGURE 19 is a side elevational view of the drive spindle of FIGURE 18.

FIGURE 20 is a cross-sectional view of the drive spindle taken along line 20-20 of FIGURE 1.

FIGURE 21 is an isometric view, partially in section, showing an idler wheel for use in the track system in FIGURE 1.

FIGURE 22 is an enlarged view taken along line 22-22 of FIGURE 1.

FIGURE 23 is an enlarged view, similar to FIGURE 22, showing the track system engaging a rock in an agricultural field.

10 Detailed Description of the Drawings

Referring to FIGURE 1, a track system incorporating a drive wheel in accordance with the present invention is generally designated by the reference numeral 10. In a preferred embodiment, the track system 10 is mounted on an axle 13 of a agricultural implement such as a tractor or combine. However, it is contemplated as being within the scope of the present invention for track system 10 to be mounted on other types of vehicles such as trucks, automobiles, and the like.

20 Track system 10 includes a drive wheel 12 which mountable to axle 13 of a vehicle 17 for rotational movement therewith in order to drive a flexible track 15. As is conventional, axle 13 extends along and is rotatable about a longitudinal axis. As best seen in
25 FIGURES 19-20, axle 13 is a planetary axle. However, it is contemplated that axle 13 be a bar axle or other type of axle without deviating from the scope of the present invention.

Referring to FIGURES 18-20, drive wheel 12 is
30 mountable on axle 13 by a mounting device 14. Mounting device 14 includes a drive spindle 16 having a generally cylindrical adaptor portion 18 with first and second opposite ends 20 and 22, respectively. Attachment flange 24 extends radially from first end 20 of adaptor portion
35 18 of drive spindle 16. Attachment flange 24 includes a first set of spaced attachment openings 26 therein which are aligned with corresponding openings 28 formed in

attachment flange 30 extending radially from axle 13. Bolts 32 extend through attachment openings 26 in attachment flange 24 of drive spindle 16 and through corresponding openings 28 in attachment flange 30 of axle 13. Nuts 34 are threaded on the ends of corresponding bolts 32 so as to capture attachment flange 24 of drive spindle 16 and attachment flange 30 of axle 13 between nuts 34 and corresponding bolt heads 36 of bolts 32, thereby interconnecting axle 13 with drive spindle 16 and allowing drive spindle 16 to rotate in unison with axle 13.

Adaptor portion 18 of drive spindle 16 further includes a plurality of circumferentially spaced slots 38 which are adjacent the first end 20 of drive spindle 16 and which are radially aligned with attachment openings 26 in attachment flange 24, and hence, with bolt heads 36 of bolts 32. Slots 38 facilitate the cooling of axle 13 and allow for access to bolt heads 36 of bolts 32 by a wrench or the like.

Second end 22 of adaptor portion 18 is substantially closed by a spindle support wall 36. The inner surface 39 of spindle support wall 36 and the inner surface 40 of adaptor portion 18 define a spindle cavity 42 within the interior of drive spindle 16. As best seen in FIGURE 20, spindle cavity 42 is dimensioned for receiving a portion of axle 13 therein.

Spindle support wall 36 further includes an opening 44 having a center lying along the longitudinal axis of axle 13. A first end 48 of center spindle 46 is received within opening 44 in support wall 36 of adaptor portion 18. A collar 50 extends about the outer surface 52 of center spindle 46 and abuts the outer surface 53 of spindle support wall 36. Center spindle 46 further includes a second, opposite key end 54. A center spindle hub 56 is positioned over the center spindle 46. Bearings, bushes or the like are positioned between the inner surface of center spindle hub 56 and the outer

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surface 52 of center spindle 46 so as to allow center spindle 46 to rotate therein.

As best seen in FIGURE 20, center spindle 46 includes a inner surface 58 which defines a passageway between the first 48 and the second 54 ends thereof. The passageway within center spindle 46 communicates with spindle cavity 42 within drive spindle 16, and allows track system 10 to be mounted onto agricultural vehicles which utilize bar axes.

Spindle support wall 36 further includes an access opening 62 therein. Access opening 62 communicates with cavity 42 within adaptor portion 46 so as to allow for an operator to gain access to cavity 42 within drive spindle 16 and lubricate axle 13.

Drive spindle 16 is also interconnected to drive wheel 12. As best seen in FIGURES 5-6, drive wheel 12 includes an inner rim 70 and an outer rim 72. Outer rim 72 includes a central hub 74 which includes a plurality of spaced attachment apertures 80 therein. Drive wheel 12 is positioned such that the radially inner edge 76 of outer rim 72 is aligned with the radially outer edge 78 of attachment flange 30 of axle 13. Attachment apertures 80 in outer rim 72 are aligned with corresponding attachment apertures 82 which are spaced in attachment flange 24 of drive spindle 16. Bolts 84 extend through attachment apertures 82 in attachment flange 24 of drive spindle 16 and through attachment apertures 80 in outer rim 72 of drive wheel 12. Nuts 86 are threaded on corresponding bolts 84 so as to capture outer rim 72 of drive wheel 12 and attachment flange 24 of drive spindle 16 between nuts 86 and corresponding bolt heads 88 of bolts 84. With drive wheel 12 interconnected to drive spindle 16 as heretofore described, rotation of axle 13 will, in turn, rotate the drive wheel 12 in unison therewith.

Outer rim 72 includes an inner rim mounting portion 90 extending radially from the longitudinal axis of axle

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13 and axially spaced from central hub 74. Inner rim mounting portion 90 is interconnected to central hub 74 by a generally conical rim wall 92 which diverges from the radially outer edge 94 of central hub 74 to the
5 radially inner edge 96 of inner rim mounting portion 90.

Outer rim 72 further includes a radially extending outer guide wall 98 which is axially spaced from inner rim mounting portion 90 of outer rim 72. Outer guide wall 98 is interconnected to inner rim mounting portion
10 90 by a generally conical connection portion 100 of outer rim 72 which diverges from the radially outer edge 102 of inner rim mounting portion 90 to the radially inner edge 104 of outer guide wall 98.

Inner rim 70 includes a radially extending mounting
15 portion 106 having a radially inner edge 108 defining a central hub receiving opening 110. Conical portion 92 of outer rim 72 is positioned with central hub receiving opening 110 in inner rim 70 such that the outer surface 112 of mounting portion 106 of inner rim 70 abuts the
20 inner surface 114 of inner rim mounting portion 90 of outer rim 72. The outer surface 112 of mounting portion 106 of inner rim 70 is interconnected to the inner surface 114 of mounting portion 102 of outer rim 72 in any suitable manner such as welding or the like.

25 Inner rim 70 further includes a radially extending inner guide wall 116 which is radially and axially spaced from mounting portion 106 of inner rim 70. Inner guide wall 116 is interconnected to mounting portion 106 of inner rim 70 by a generally conical connection wall 118
30 which diverges from the radially outer edge 120 of mounting portion 106 of inner rim 70 to the radially inner edge 122 of inner guide wall 116. Outer guide wall 98 of outer rim 72 and inner guide wall 116 of inner rim 70 are generally parallel to each other and are axially
35 spaced so as to define a circumferentially extending channel 124 in the radially outer edge of drive wheel 12.

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A plurality of circumferentially spaced rollers are mounted within channel 124 of drive wheel 12. Referring to FIGURE 8, a first embodiment of a roller for mounting in circumferentially extending channel 124 in drive wheel 12 is generally designated by the reference numeral 126. Each roller 126 includes a tubular, generally cylindrical outer sleeve 128. Outer sleeve 128 extends along a longitudinal axis and includes an inner surface 130 which defines a passageway between first and second ends 132 and 134, respectively, thereof. The first end 132 of outer sleeve 128 abuts the inner surface 136 of inner guide wall 116. Similarly, second end 134 of outer sleeve 128 abuts the inner surface 138 of outer guide wall 98.

Bearing sleeve receipt pockets 140 and 142 are formed in the inner surfaces 136 and 138 of corresponding guide walls 116 and 98, respectively. Each roller 126 further includes a bearing sleeve 144 which extends through the passageway in outer sleeve 128. Bearing sleeve 144 includes a generally cylindrical inner surface 146 which defines a bolt receiving passageway between the first end 148 and the second end 150 of bearing sleeve 144. Bearing sleeve 144 further includes a generally cylindrical outer surface 152. The outer surface 152 of bearing sleeve 144 forms a rotational interface with the inner surface 130 of outer sleeve 128 such that outer sleeve 128 is rotatable on bearing sleeve 144.

Upper portions 160 and 162 of inner and outer guide walls 116 and 98, respectively, include a plurality of circumferentially spaced pairs of apertures 164 and 166 therethrough. Each of the pairs of apertures 164 and 166 are aligned within corresponding pockets 140 and 142 in inner and outer guide walls 116 and 98, respectively.

In order to interconnect rollers 126 to drive wheel 12, each roller 126 is positioned within circumferentially extending channel 124 in drive wheel 12 such that a first end 148 of bearing sleeve 144 is seated

within a corresponding pocket 140 in the inner surface 136 of inner guide wall 116. A second end 150 of bearing sleeve 144 is seated within corresponding pocket 142 in the inner surface 138 of outer guide wall 98.

5 Bolts 170 are inserted through corresponding apertures 164 and 166 in inner and outer guide walls 116 and 98, respectively and through bolt receiving passageway in bearing sleeve 144. Each bolt 170 includes an enlarged head 172 on a first end thereof which abuts
10 the outer surface 174 of inner guide wall 116. A second, opposite, threaded end 176 extends through corresponding aperture 166 in outer guide wall 98. Nuts 180 are threaded onto the threaded ends 176 of bolts 170 so as to capture bearing sleeves 144 within corresponding pockets
15 140 and 142 in corresponding inner and outer guide walls 116 and 98, respectively, and to prevent rotational movement of bearing sleeves 144 therebetween.

Referring to FIGURE 9, a second embodiment of a roller for mounting in the circumferentially extending
20 channel 124 in drive wheel 12 is generally designated by the reference numeral 190. Each roller 190 includes a tubular, generally cylindrical outer sleeve 192. Outer sleeve 192 extends along a longitudinal axis and includes an inner surface 194 which defines a passageway between
25 first and second ends 196 and 198, respectively, thereof. The first end 196 of outer sleeve 192 abuts the inner surface 136 of inner guide wall 116. Similarly, second end 198 of outer sleeve 192 abuts the inner surface 138 of outer guide wall 98.

30 Bushing pockets 200 and 202 are formed in inner surfaces 136 and 138 of corresponding guide walls 116 and 98, respectively. Upper portions 160 and 162 of inner and outer guide walls 116 and 98, respectively, include a plurality of circumferentially spaced pairs of apertures
35 204 and 206 therethrough. Each of the pairs of apertures 204 and 206 are aligned within corresponding pockets 200

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and 202 in inner and outer guide walls 116 and 98, respectively.

Each roller 190 further includes first and second bushings 208 and 210, respectively, which are received in corresponding ends 196 and 198 of outer sleeve 192. Bushings 208 and 210 include corresponding bearing portions 212 and 214. Bearing portions 212 and 214 of bushings 208 and 210, respectively, include a generally outer surface 216 and 218, respectively. Enlarged heads 220 and 222 extend radially from one end of bearing portions 212 and 214 of bushings 208 and 210, respectively. Bushings 208 and 210 further include corresponding bolt passageways 224 and 226, respectively, therethrough.

In order to assemble each roller 190, bearing portion 216 of bushing 208 is inserted into passageway 194 in outer sleeve 192 through end 196 such that enlarged head 220 of bushing 208 abuts end 196 of outer sleeve 192. Similarly, bearing portion 214 of bushing 210 is inserted into passageway 194 through end 198 of outer sleeve 192 such that enlarged head 222 of bushing 210 abuts end 198 of outer sleeve 192. The inner surface 194 of outer sleeve 192 forms a rotational interface with the outer surfaces 216 and 218 of bearing portions 212 and 214 of bushings 208 and 210, respectively. Each roller 190 is positioned within circumferentially channel 124 in drive wheel 12 such that enlarged head 220 of bushing 208 is seated within a corresponding pocket 200 in the inner surface 136 of inner guide wall 116 and such that enlarged head 222 of each bushing 210 is seated within a corresponding pocket 202 in the inner surface 138 of outer guide wall 98.

Bolts 170 are inserted through corresponding pairs of apertures 204 and 206 in inner and outer guide walls 116 and 98, respectively. The shaft 171 of each bolt extends through passageways 224 and 226 in bushings 208 and 210, respectively, and through passageway 194 in

outer sleeve 192. Nuts 180 are threaded onto the threaded ends 176 of bolts 170 so as to support rollers 190 between guide walls 116 and 98.

Referring to FIGURE 10, a third embodiment of a roller for mounting in circumferentially extending channel 124 in drive wheel 12 is generally designated by the reference numeral 230. Each roller 230 includes a tubular, generally cylindrical outer sleeve 232. Outer sleeve 232 extends along a longitudinal axis and includes an inner surface 234 which defines a passageway between first and second ends 236 and 238, respectively, thereof. Outer sleeve 232 further includes first and second enlarged heads 240 and 242, respectively. Enlarged heads 240 and 242 are generally conical in shape and include guide surfaces 244 and 246, respectively, which diverge from each other and from the outer surface 248 of outer sleeve 232.

Each roller 230 further includes a bearing sleeve 250 which extends through passageway in outer sleeve 232. Bearing sleeve 250 includes a generally cylindrical inner surface 252 which defines a bolt receiving passageway between the first and second ends 254 and 256, respectively, thereof. Each bearing sleeve 250 further includes a generally cylindrical outer surface 258 which forms a rotational interface with the inner surface 234 of a corresponding outer sleeve 232 such that outer sleeve 232 is rotatable on bearing sleeve 250.

Bearing sleeve receipt pockets 260 and 262 are formed in the inner surfaces 136 and 138 of corresponding guide walls 116 and 98, respectively. Upper portions 160 and 162 of inner and outer guide walls 116 and 98, respectively, include a plurality of circumferentially spaced pairs of holes 264 and 266 therethrough. Each of the pair of holes 264 and 266 are aligned with corresponding pockets 260 and 262 in inner and outer guide walls 116 and 98, respectively.

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In order to assemble rollers 230, each roller 230 is positioned within circumferentially extending channel 124 in drive wheel 12 such that a first end 254 of bearing sleeve 250 is seated within corresponding pocket 260 in the inner surface 136 of inner guide wall 116. Second end 256 of each bearing sleeve 250 is seated within corresponding pocket 262 in inner surface 138 of outer guide wall 98. Bolts 170 are inserted through corresponding holes 264 and 266 in inner and outer guide walls 116 and 98, respectively and through bolt receipt passageways in bearing sleeves 252. The enlarged head 172 of each bolt 170 abuts the outer surface 174 of inner guide wall 116. Nuts 180 are threaded onto a threaded end 176 of each bolt 170 so as to capture each bearing sleeve 250 between corresponding pockets 260 and 262 in corresponding inner and outer guide walls 116 and 98, respectively, and to prevent rotational movement of each bearing sleeve 250 therebetween.

As best seen in FIGURE 5, a frame 274 is positioned about drive wheel 12 and rigidly connected to the vehicle. Referring to FIGURES 2-3, a leading idler assembly 276 is pivotably mounted to frame 274 at the proximal ends 278 of leading idler arms 280. Idler arms 280 extend downwardly from frame 274 and define a drive wheel passageway 281 therebetween. Leading idler arms 280 rotatably support corresponding idler axles 282.

Referring to FIGURE 14, idler axles 282 extend laterally from outer surfaces 283 of corresponding leading idler arms 280. Each idler axle 282 includes a mounting cap 284 having a generally cylindrical mounting portion 286 of a diameter generally equal to the diameter of axle mounting opening 288 in each leading idler arm 280. Mounting portions 286 of mounting caps 284 are secured within axle mounting openings 288 in corresponding leading idler arms 280 by any suitable means such as welding or the like. Each mounting cap 284 further includes an enlarged head 290 which extends

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radially from the outer surface 292 of mounting portion 286 and which abuts the outer surface 283 of a corresponding leading idler arm 280.

Each mounting cap 284 defines an shaft receiving
5 cavity 296 which receives a first end 298 of a corresponding shaft 300. Each shaft 300 is rigidly connected to corresponding mounting cap 284 by a bolt 302 which extends through mounting portion 286 of each mounting cap 284 and into first end 298 of corresponding
10 shaft 300. In addition, an anti-rotation pin 301 is inserted through mounting portion 286 of each mounting cap 284 into a corresponding shaft 300 so as to prevent rotation of shaft 300.

Each idler axle 282 further includes a rotatable
15 sleeve 304 mounted over corresponding shaft 300. Each rotatable sleeve includes a first end which abuts enlarged head 290 of a corresponding mounting cap 284 and a second, opposite end. Bearings, bushings or the like may be positioned between the inner surface 303 of
20 rotatable sleeve 304 and the outer surface 305 of corresponding shaft 300 in order to facilitate rotation of rotatable sleeve 304 on corresponding shaft 300.

Idler wheels 306 are mounted on rims 307, FIGURE 1, in a conventional manner which, in turn, are mounted on
25 corresponding rotatable sleeves 304 of idler axles 282 in a conventional manner for rotational movement therewith.

Referring to FIGURES 21-23, each idler wheel 306 is non-pneumatic and is constructed from a rubber or rubber-like material. Each idler wheel 306 includes a generally
30 cylindrical inner surface 308 which is dimensioned for receipt on a conventional rim 307, and a radially outer surface 312 having a plurality of treads thereon for engaging the inner surface 343 of flexible track 15.

Each idler wheel 306 further includes a first set of
35 air cavities 314 therein. The first set of air cavities 314 are spaced from each other at a predetermined radial distance from the axial center of idler wheel 306. In

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addition, each idler wheel 306 includes a second set of air cavities 316 which are spaced about each idler wheel 306 at a predetermined distance from the axial center of idler wheels 306. The second set of air cavities 316 are spaced at a greater predetermined radial distance from the axial center of idler wheels 306 than the first set of air cavities 314.

The first and second sets of air cavities 314 and 316, respectively, in idler wheels 306 are arranged to allow for the radially outer surface 312 of idler wheel 306 to deflect a predetermined amount in response to external force on the radially outer surface 312, FIGURE 23. It is contemplated that being within the scope of the present invention to arrange the first and second set of air cavities 314 and 316, respectively, in other patterns within idler wheel 306 in order to obtain the proper deflection of the outer surface 312 of idler wheel 306 in response to a predetermined external force thereon.

Referring to FIGURES 13 and 15-17, track system 10 further includes a guide wheel 320 positioned within the drive wheel passageway 281 between leading idler arms 280, FIGURE 3. Guide wheel 320 includes a central hub 322 having a generally cylindrical outer surface 324 and a generally cylindrical inner surface 326 which defines a passageway therethrough.

Guide wheel 320 further includes first and second guide walls 328 and 330, respectively, which extend radially from opposite ends 332 and 334 of central hub 322. Each guide wall 328 and 330 terminates at a radially outer edge 336 and 338, respectively. As best in FIGURE 17, the outer edges 336 and 338 of corresponding guide walls 328 and 330, respectively, have a predetermined radius such that the outer edges 336 and 338 of guide walls 328 and 330, respectively, form a mating relationship with junctions 339 and 340, respectively, of each lug 341 extending from the inner

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surface 343 of flexible track 15. As best seen in FIGURE 15, guide walls 328 and 330 define a circumferentially extending lug receiving channel 342 therebetween having a predetermined width greater than the width of each lug 341.

Inner surface 326 of central hub 322 defines enlarged bearing receiving bores 347 and 349 at opposite ends 332 and 334, respectively, thereof. A separation tube 349 is received within the passageway defined by the inner surface 326 of central hub 322 and thereafter mounted on a guide wheel shaft 342. Bearings are positioned about the guide wheel shaft 342 within corresponding bearing receiving bores 347 and 349 such that guide wheel 320 is rotatable on separation tube 349 about guide wheel shaft 342.

Guide wheel shaft 342 extends between first and second guide wheel support arms 344 and 346, respectively, which depend from frame 274. As best seen in FIGURE 13, guide wheel shaft 342 is parallel to and radially spaced from idler axles 282 of leading idler assembly 276. Guide wheel shaft 342 includes a collar 348 which extends radially from the outer surface 350 thereof at a location adjacent a first end 352 of shaft 342. An adjustable nut 354 is mounted a second end 356 of shaft 342 so as to capture guide wheel 320 on shaft 342 therebetween. Nut 354 may be rotated on a threaded portion of guide wheel shaft 342 so as to vary the axial distance between nut 354 and collar 348 in order to limit lateral movement of guide wheel 320 along guide wheel shaft 342.

Referring to FIGURE 4, track system 10 further includes a trailing idler assembly 360 which is rigidly mounted to frame 274 at the proximal ends 361 of trailing idler arms 362. Trailing idler arms 362 define a second drive wheel passageway 367 therebetween such that drive wheel 12 may pass therebetween. Distal ends 366 of trailing idler arms 362 support corresponding

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idler axles 282. Each idler axle 282 is mounted within the distal end 366 of a corresponding trailing idler arm 362 in the same manner as idler axles 282 are mounted in corresponding leading idler arms 280 and hence, the description heretofore of the mounting of the idler axles 282 in the leading idler arms 280 is understood to describe the mounting of the idler axles 282 in their corresponding trailing idler arms 362 as if described fully herein.

Idler wheels 306 for trailing idler assembly 360 are mounted on corresponding rotatable sleeves 304 of idler axles 282 as heretofore described. The radially outer surface 312 of each idler wheel 306 of trailing idler assembly 360 engages the inner surface 343 of flexible track 15. As previously described, the first and second sets of air cavities 314 and 316, respectively, in idler wheels 306 are arranged to allow for the radially outer surface 312 of each idler wheel 306 of trailing idler assembly 360 to deflect in response to an external force on the radially outer surface 312 thereof.

Track system 10 further includes a mid-roller or bogie assembly 380 positioned between leading idler assembly 276 and the trailing idler assembly 360, FIGURES 1-2. As best seen in FIGURES 11-12, bogie assembly 380 includes first and second bogie wheel support members 382 and 384, respectively, transverse in the longitudinal axis of the axle 13 of the vehicle. Each bogie wheel support member 382 and 384 is interconnected to a corresponding trailing idler arm 362 by a bogie connection arm 389, FIGURE 2. Bogie connection arms 389 include inner and outer plates 391 and 393, respectively, interconnected by a plurality of bolts. Each plate 391 and 393 includes a plurality of offset bolt openings 395 which allow a user to adjust the length of bogie connection arm 389 in a conventional matter by lining up different bolt openings 395 in each plate 391 and 393. Outer plates 393 of bogie connection arms 389 have

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proximal ends 392 welded to the outer edge of corresponding trailing idler arms 362. A proximal ends 394 of inner plates 391 of bogie connection arms 389 are interconnected to the trailing ends of corresponding bogie wheel support member 382 and 384.

Each bogie wheel support member 382 and 384 rotatably supports a leading bogie wheel 388 and trailing bogie wheel 390. Each bogie wheel 388 and 390 is rotatably supported on a bogie stub axle 392 which extends laterally from a corresponding bogie wheel support member 382 and 384. Each bogie stub axle 392 includes a mounting cap 394 having a generally cylindrical mounting portion 396 of a diameter generally equal to the diameter of a corresponding bogie axle mounting opening 398 in bogie wheel support members 382 and 384.

Mounting portion 396 of each mounting cap 394 is secured within a corresponding bogie axle mounting opening 398 by any suitable means such as welding or the like. Each mounting cap 394 further includes an enlarged head 400 which extends radially from the outer surface 402 of mounting portion 396 and which abuts the outer surface of a corresponding bogie wheel support members 382 and 384.

Each mounting cap 394 defines a shaft receiving cavity 406 which receives a first end 408 of a corresponding shaft 410. Each shaft 410 is rigidly connected to mounting cap 394 by a bolt 412 which extends through mounting portion 396 of each mounting cap 394 and into the first end 408 of corresponding shaft 410. In addition, an anti-rotation pin 404 is inserted through mounting portion 396 of each mounting cap 394 and into a corresponding shaft 410 so as to prevent rotation of shaft 410 within its corresponding mounting cap 394.

Each bogie wheel 388 and 390 is mounted on a rim 411 which, in turn, is mounted in a conventional manner on shaft 410 of corresponding bogie stub axle 392 for

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rotational movement thereon, FIGURE 1. Each bogie wheel 388 and 390 also includes radially outer surface 416 which engages the inner surface 343 of flexible track 15 along the lower length thereof.

5 Each bogie wheel 388 and 390 is non-pneumatic and constructed from a rubber or rubber-like material and includes a plurality of spaced air cavities 418 which are spaced from each other at a predetermined radial distance from the axial center of each bogie wheel 388 and 390.

10 Air cavities 418 in bogie wheels 388 and 390 are arranged to allow for the radially outer surface 416 of bogie wheels 388 and 390 to deflect a predetermined amount in response to an external force on the outer surface 416 thereof. It is contemplated that air cavities 418 be

15 arranged in other patterns in corresponding bogie wheels 388 and 390 to insure proper deflection of the radially outer surface 416.

As best seen in FIGURE 4, track system 10 also includes a trailing guide wheel 320a positioned with

20 drive wheel passageway 367 between trailing idler arms 362. Trailing guide wheel 320a is identical to leading guide wheel 320 and as such, the previous description of leading guide wheels 320 is understood to describe trailing guide wheel 320a. Trailing guide wheel 320a is

25 rotatably supported by trailing guide wheel shaft 420 which extends between first and second trailing guide wheel support arms 322 and 324, respectively, that depend from frame 274. As best seen in FIGURE 2, trailing guide wheel shaft 420 is parallel to and radially spaced from

30 idler axles 282 of trailing idler assembly 350. Trailing guide wheel shaft 420 includes a collar 426 which extends radially from the outer surface 428 thereof at a location adjacent a first end 430 of shaft 420. An adjustable nut 432 is mounted on a second end 434 of trailing guide

35 shaft 420 so as to capture trailing guide wheel 320a on trailing guide wheel shaft 342 therebetween. Nut 432 may be rotated on a threaded portion of trailing guide wheel

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shaft 420 so as to vary the axial distance between nut 432 and collar 426 in order to limit the lateral movement of guide wheel 320a along trailing guide wheel shaft 420.

As best seen in FIGURE 1, track system 10 may also include a cover plate 440 mounted to the exterior portion of frame 274. Cover plate 440 discourages the accumulation of soil and debris within track system 10, and in addition, discourages the accidental access to the interior of track system 10 during operation of vehicle 17.

In operation, track system 10 is mounted to axle 13 through drive wheel 12 as heretofore described. Axle 13 of vehicle 17 is rotated in a conventional manner through the vehicle 17 by its engine and through a transmission which can vary the speeds and allow forward and reverse rotation.

Flexible track 15 of track apparatus 10 is positioned over drive wheel 12 such that the radially outer edges 442 and 444 of inner and outer guide walls 116 and 98, respectively, engage the inner surface 343 of flexible track 15. As drive wheel 12 rotates, radially outer edges 442 and 444 of inner and outer guide walls 116 and 98, respectively, of drive wheel 12 form a mating relationship with junctions 339 and 340, respectively, of lug 341 so as to guide lugs 341 into the area between rollers mounted within the circumferentially extending channel 124 in drive wheel 12, FIGURE 8. As drive wheel 12 continues to rotate, rollers mounted within the circumferentially extending channel 124 in drive wheel 12 engage lug 341 and drives flexible track 15 about drive wheel 12. Thereafter, each successive roller engages a subsequent lug 341 extending from the inner surface 343 of flexible track 15 so as to drive flexible track 15 about drive wheel 12 in the manner heretofore described. As heretofore described, each roller is rotatable within circumferentially extending channel 124 in drive wheel 12

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so as to minimize damage to lugs 341 of flexible track 15 during engagement therewith.

As flexible track 15 approaches guide wheels 306 of leading idler assembly 274, lugs 341 pass between guide
5 walls 328 and 330 of leading guide wheel 320. The radially outer edges 336 and 338 of guide walls 328 and 330, respectively, of leading guide wheel 320 form a mating relationship with junctions 338 and 340, respectively, of each lug 341 so as to prevent lateral
10 movement of flexible track 15. In addition, the radially outer surfaces 312 of idler wheels 306 of leading idler assembly 276 engage the inner surface 343 of flexible track 15 and direct the lower length of flexible track 15 into contact with a supporting surface 348 such as a
15 farmer's field.

As flexible track 15 is driven about drive wheel 12, the lugs 341 pass between leading and trailing bogie wheels 388 and 390, respectively, of bogie wheel support member 382 and leading and trailing bogie wheels 388 and
20 390, respectively, of bogie wheel support member 384. As previously described, the radially outer surface 416 of each bogie wheel 388 and 390 engages the inner surface 343 of flexible track 15 along its lower length and insures contact of flexible track 15 with supporting
25 surface 448 along the lower length of flexible track 15.

As flexible track 15 approaches trailing idler assembly 360, lugs 341 on the inner surface 343 of flexible track 15 are captured between first and second guide walls 328 and 330, respectively, of trailing guide
30 wheel 320a. The outer edges 336 and 338 of guide walls 328 and 330, respectively, of trailing guide wheel 320a form a mating relationship with junctions 338 and 340, respectively, of each lug 341 extending from the inner surface 343 of flexible track 15 so as to prevent lateral
35 movement of flexible track 15. In addition, the radially outer surfaces 312 of idler wheels 306 of trailing idler assembly 360 engage the inner surface 343 of flexible

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track 15 and guide flexible track 15 onto drive wheel 12 to form a continuous loop.

It is contemplated as being the scope of the present invention to rotate drive wheel 12 in a second, opposite
5 direction such that trailing idler assembly 360 may function as a leading idler assembly, and such that leading idler assembly 276 may function as a trailing idler assembly as heretofore described.

Various modes of carrying out the invention are
10 contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter as regarded as the invention.

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I CLAIM:

1. A guide wheel for a track apparatus having a frame; a continuous flexible track with upper and ground-engaging lower lengths and an inner surface having a lug projecting therefrom; a drive wheel structure rotatably mounted with respect to the frame and having an upper circumferential portion engaging the inner surface of the flexible track along the upper length and a lower circumferential portion spaced above the lower track length; and an idler assembly attached to the frame and having an idler wheel engaging the flexible track, the guide wheel comprising:
- a central hub rotatably mounted to the frame;
 - a first guide wall extending radially from the central hub and terminating at an outer edge; and
 - a second guide wall extending radially from the central hub and terminating at an outer edge, the first and the second guide walls guiding the flexible track onto the idler wheel.

2. The guide wheel of claim 1 wherein the first and second guide walls define a circumferentially extending lug-receiving channel in the guide wheel wherein receipt of the lug in the lug-receiving channel prevents lateral movement of the flexible track.

3. The guide wheel of claim 1 wherein the outer edge of the first guide wall has a predetermined radius such that the outer edge of the first guide wall forms a mating relationship with a portion of the continuous flexible track adjacent the lug.

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4. The guide wheel of claim 3 wherein the outer edge of the second guide wall has a predetermined radius such that the outer edge of the second guide wall forms a mating relationship with a second portion of the continuous flexible track adjacent the lug.

5. A track apparatus having a frame, the track apparatus mountable on a rotatable axle of a vehicle, comprising:

- 10 -a continuous flexible track having an upper length and a ground-engaging lower length and including an inner surface, the inner surface of the flexible track having a plurality of lugs projecting therefrom;
- 15 -a drive wheel mountable to the rotatable axle of the vehicle for rotational movement therewith, the drive wheel sequentially engaging the plurality of lugs projecting from the inner surface of the flexible track along the upper length to drive the flexible track in response to rotation of the axle of the vehicle;
- 20 -a leading idler assembly mounted to the frame, the leading idler assembly including a rotatable, leading idler wheel engaging the inner surface of the flexible track; and
- 25 -a leading guide wheel rotatably mounted to the frame, the leading guide wheel including a circumferentially extending lug-receiving channel for sequentially receiving the plurality of lugs therein and guiding the flexible track onto the leading idler wheel.
- 30

6. The track apparatus of claim 5 further comprising a trailing idler assembly mounted to the frame and including a rotatable, trailing idler wheel for engaging the inner surface of the flexible track.

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7. The track apparatus of claim 6 further comprising a trailing guide wheel rotatably mounted to the frame, the trailing guide wheel engaging the inner surface of the flexible track and guiding the flexible track onto the trailing idler wheel.

8. The track apparatus of claim 5 further comprising a mid-roller assembly mounted to the frame and engaging the inner surface of the flexible track along the lower length.

9. The track apparatus of claim 5 wherein the leading guide wheel includes a central hub having first and second guide walls projecting radially therefrom, the guide walls defining the lug-receiving channel in the leading guide wheel.

10. The track apparatus of claim 9 wherein each of the guide walls of the leading guide wheel terminates at a radially outer edge, the radially outer edge of each guide wall having a predetermined radius.

11. The track apparatus of claim 10 wherein each of the plurality of lugs projecting from the inner surface of the flexible track includes first and second side walls, each side wall intersecting the inner surface of the flexible track at a junction.

12. The track apparatus of claim 11 wherein the junction of each side wall of each lug with the inner surface of the flexible track has a predetermined radius.

13. The track apparatus of claim 12 wherein the predetermined radius of the outer edge of each guide wall of the leading guide wheel is generally equal to the predetermined radius of each junction.

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14. A track apparatus having a frame, the track apparatus mountable on a rotatable axle of a vehicle, comprising:

- 5 -a continuous flexible track having an upper length and a ground-engaging lower length and including an inner surface, the inner surface of the flexible track having a plurality of lugs projecting therefrom;
- 10 -a drive wheel mountable to the rotatable axle of the vehicle for rotational movement therewith, the drive wheel sequentially engaging the plurality of lugs projecting from the inner surface of the flexible track along the upper length so as to drive the flexible track in response to rotation of the
- 15 axle of the vehicle;
- a leading idler assembly mounted to the frame and including first and second leading idler wheels, the leading idler wheels rotatable about and spaced along a common idler axis parallel to the axle of
- 20 the vehicle; and
- a leading guide wheel positioned between the first and second leading idler wheels and rotatably mounted to the frame, the leading guide wheel rotatable about a guide wheel axis parallel to and
- 25 radially spaced from the idler axis.

15. The track apparatus of claim 14 wherein the leading idler assembly includes first and second stub axles rotatably mounted to the frame, each leading idler

30 wheel mounted on a corresponding stub axle.

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16. The track apparatus of claim 14 wherein the leading guide wheel includes a central hub having first and second guide walls extending radially therefrom and terminating at a radially outer edge, the first and the second guide walls defining a circumferentially extending lug-receiving void in the leading guide wheel wherein receipt of one of the plurality of lugs in the lug-receiving void prevents lateral movement of the flexible track.

10

17. The track apparatus of claim 16 wherein the outer edge of each guide wall of the leading guide wheel has a predetermined radius.

15

18. The track apparatus of claim 14 further comprising a trailing idler assembly mounted to the frame and including first and second trailing idler wheels, the trailing idler wheels rotatable about and spaced along a common trailing idler axis parallel to the axle of the vehicle.

20

19. The track apparatus of claim 18 further comprising a trailing guide wheel positioned between the first and second trailing idler wheels and rotatably mounted to the frame, the trailing guide wheel rotatable about a trailing guide wheel axis parallel to and radially spaced from the trailing idler axis.

25

20. The track apparatus of claim 19 wherein the trailing guide wheel includes a central hub having first and second guide walls extending radially therefrom and terminating at a radially outer edge, the first and the second guide walls defining a circumferentially extending lug-receiving void in the trailing guide wheel wherein receipt of one of the plurality of lugs in the lug-receiving void prevents lateral movement of the flexible track.

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21. The track apparatus of claim 20 wherein the outer edge of each guide wall of the trailing guide wheel has a predetermined radius.

- 5 22. The track apparatus of claim 14 further comprising a mid-roller assembly mounted to the frame and engaging the inner surface of the lower length of the flexible track.

FIG. 1

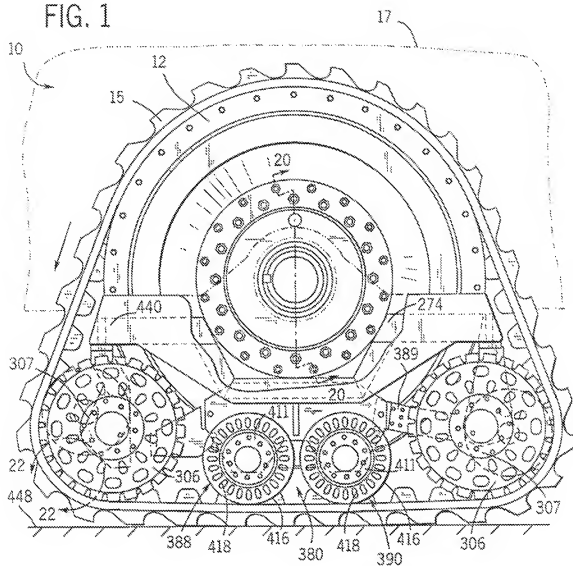
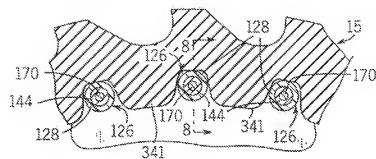
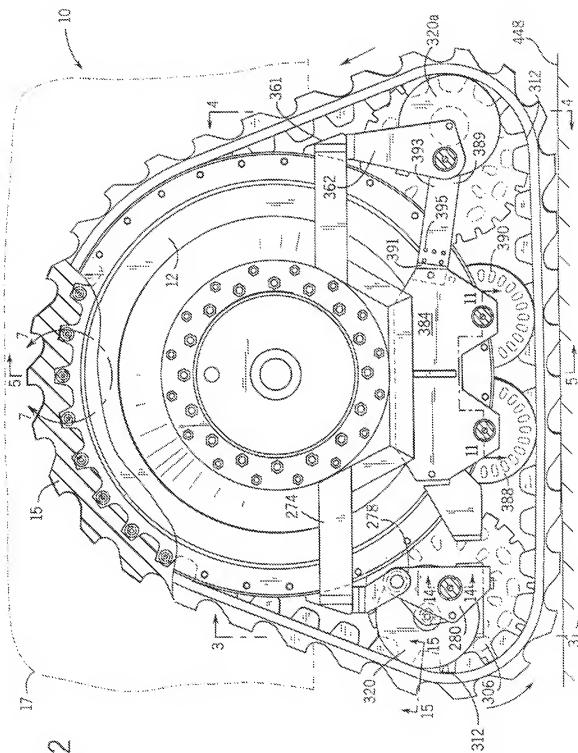


FIG. 7





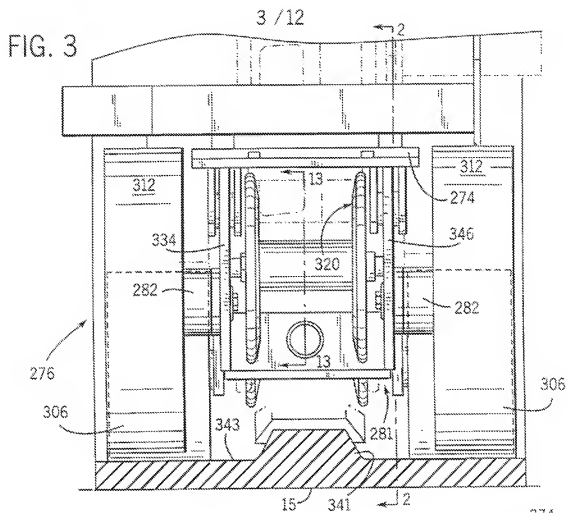


FIG. 4

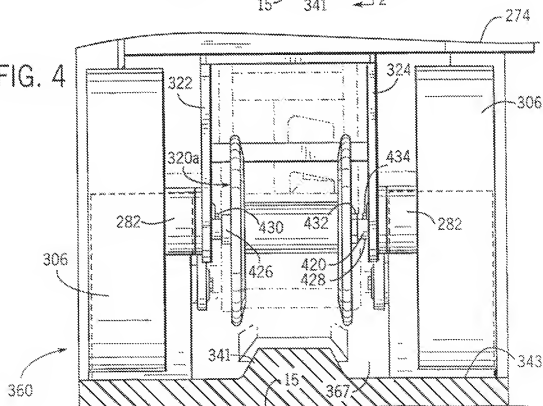
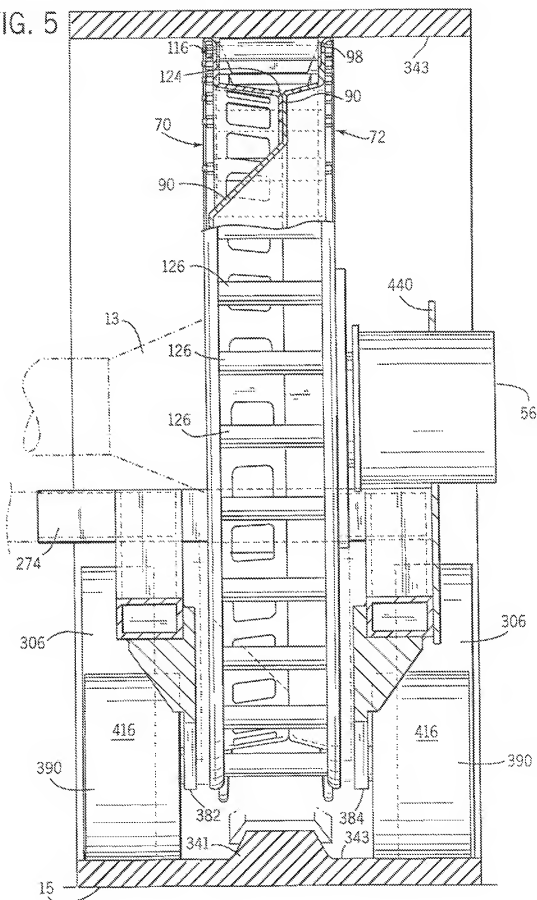
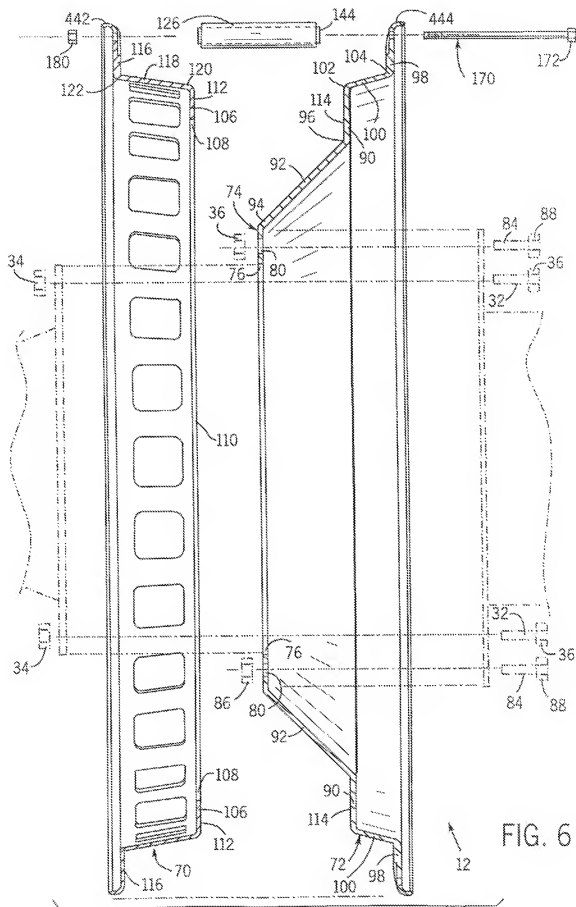


FIG. 5





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FIG. 8

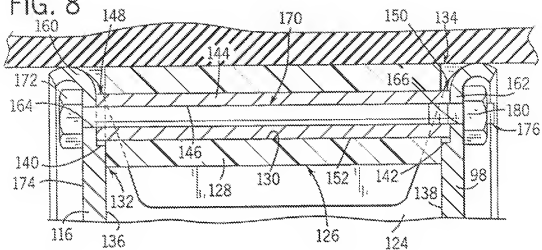


FIG. 9

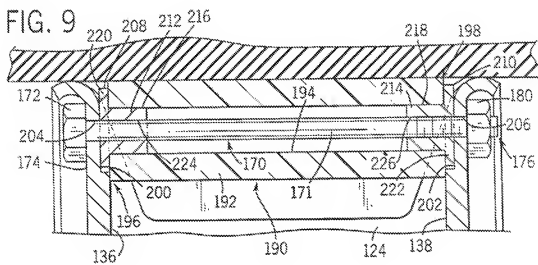
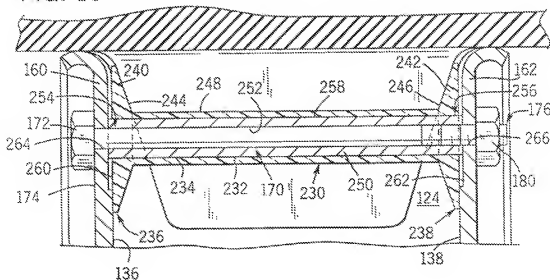


FIG. 10



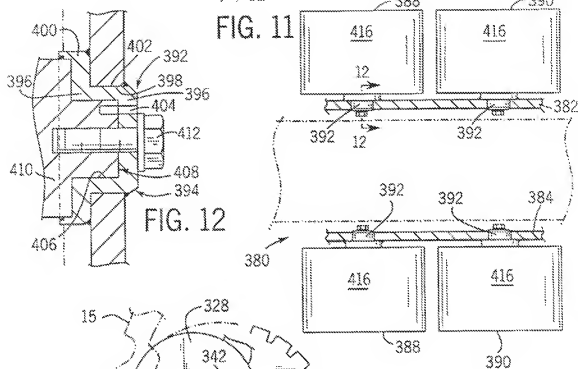
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FIG. 11

FIG. 13

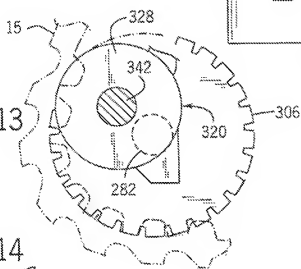


FIG. 14

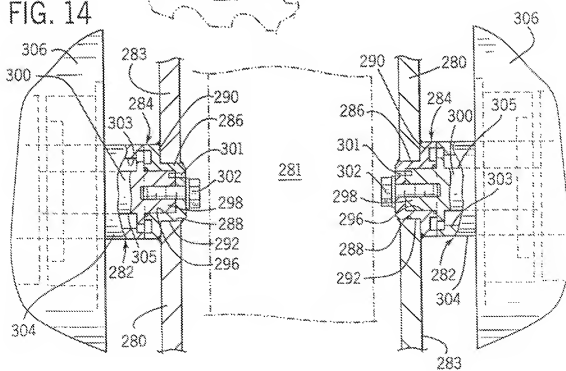


FIG. 15

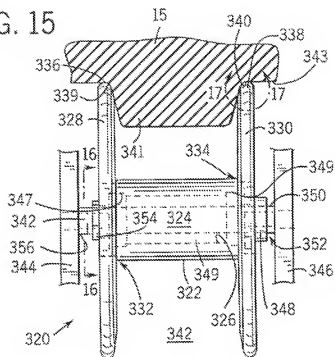


FIG. 16

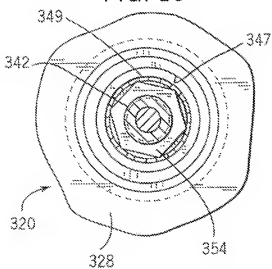


FIG. 17

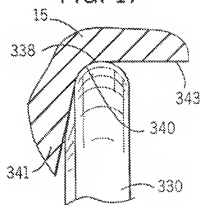
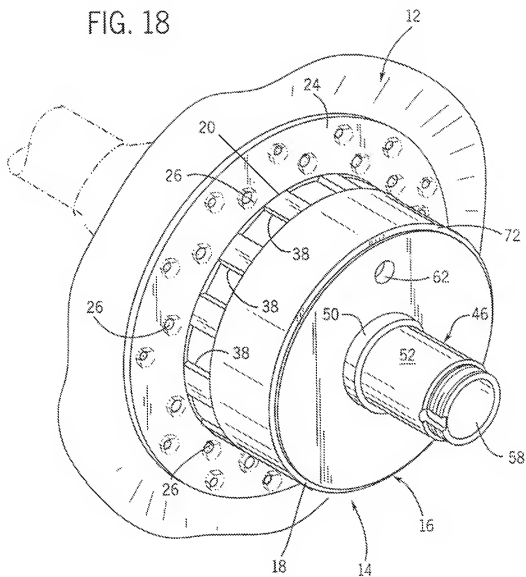
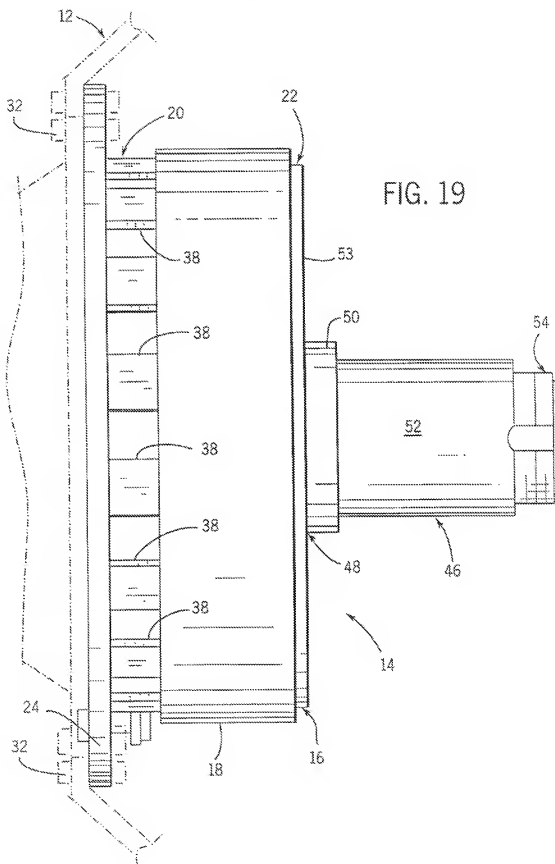


FIG. 18



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FIG. 20

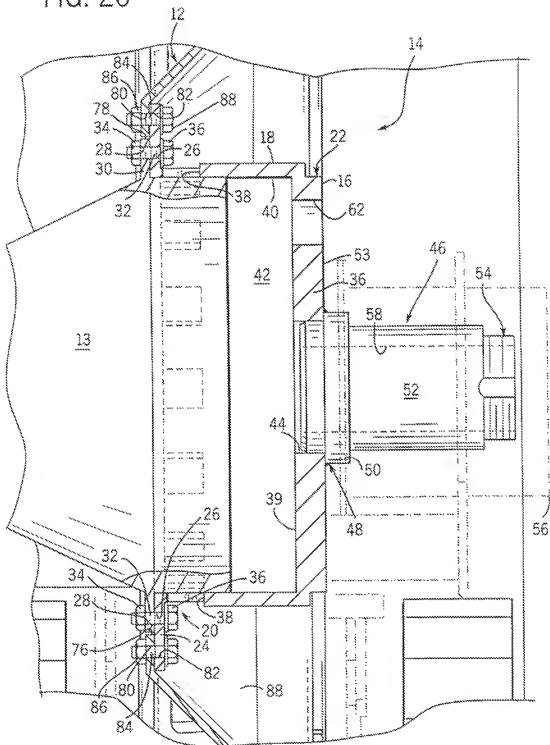
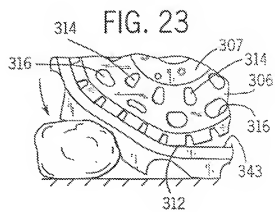
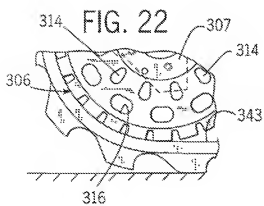
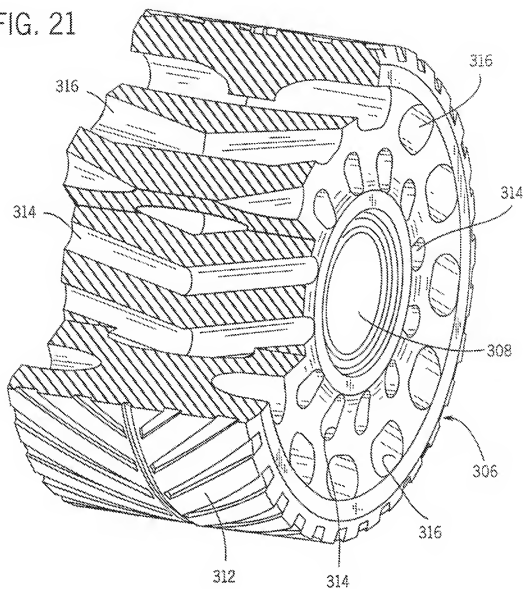


FIG. 21



INTERNATIONAL SEARCH REPORT

International application No.

PCT/ISA99/15318

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : B62D 55/14

US CL : 305/115, 125, 130, 135, 137, 138, 194, 199

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,191,952 A (Satzler et al.) 09 March 1993, all pages.	1-4
A	US 5,899,542 A (Lykken et al.) 04 May 1999.	All
A	US 5,452,949 A (Kelderman) 26 September 1995.	All
A	US 5,373,909 A (Dow et al.) 20 December 1994.	All
A	US 5,343,960 A (Gilbert) 06 September 1994.	All
A	US 5,340,205 A (Nagorecka) 23 August 1994.	All
A	US 5,293,948 A (Crabb) 15 March 1994.	All
A	US 3,870,371 A (Solomon) 11 March 1975.	All

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents	* Documents published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
* A document defining the general state of the art which is not considered to be of particular relevance	* Documents of particular relevance: two claimed inventions cannot be considered novel or distinct if they are considered to involve an inventive step when the document is taken alone
* B earlier document published on or after the international filing date	* Documents of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
* C document which may throw doubts on priority claims or which is cited to establish the publication date of another citation or other special reason (as specified)	* Documents of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
* D document referring to an oral disclosure, use, exhibition or other means	* Documents of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
* E document published prior to the international filing date but later than the priority date claimed	* Documents of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Date of the actual completion of the international search	Date of mailing of the international search report
01 SEPTEMBER 1999	21 OCT 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer LONG BAONUYEN
Facsimile No. (703) 305-3230	Telephone No. (703) 305-5201

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US99/15318

B. FIELDS SEARCHED

Minimum documentation searched

Classification System: U.S.

305/115, 124, 125, 129, 130, 135, 136, 137, 138, 157, 160, 165, 169, 170, 178, 193, 194, 195, 199, 180/9.62, 301/1, 6.1, 105.1, 111